CEPAT Journal of Computer Engineering: Progress, Application and Technology
Vol. 1, No. 2, August 2022, pp. 41-52
ISSN: 2963-6728, DOI: https://doi.org/10.25124/cepat.v1i02.5245

Study of neuromarketing in consumer behaviour due to product logos colour changes effect

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Article Info

Article history:

Received August 3, 2022
Revised August 19, 2022
Accepted August 29, 2022

Keywords:

Branding
Consumer Behavior
Neuromarketing
Electroencephalography (EEG)
Logo Color

ABSTRACT

Consumer behavior can be measured by conducting surveys, but this method lacks the depth of analysis. By utilizing technological and scientific advances through the study of neuroscience, especially in neuromarketing, it is hoped to improve the specific data when analyzing consumer behavior. Neuromarketing has been widely used to measure consumer behavior through several stimulation, including logo colors of a brand. Neuromarketing is applied using electroencephalography (EEG) signal analysis to the human brain's response. In this paper, data collection was carried out on six students aged 19-24 years. Those six respondents were given a stimulus of five original logo colors and five recolored of each logo and were questioned in three sessions. This signal was pre-processed with a butterworth bandpass filter with a theta-band frequency band in the range of 4-8 Hz. Using questionnaires when collecting data from respondents, and the EEG signal data is processed by spatial and spectral domains to view the active areas of short-term memory. The result obtained is the effect of the change of logo's color on consumer memory and the active location of short-term memory of the logo's color. Using spatial selection, the number of channels was reduced by 75%, from 16 to 4 channels. The selected channels are in the memory and visual areas. This paper gives that the original logo color is more recognized than the modified logo color, and it is hoped that this research can help some company to determine the color for their brand logo, what is the effect when the company try to remake their brand logo, so that the brand logo is more recognizable and easier to remember by customers.

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1. INTRODUCTION

Marketing is the identification activity of a company or institution that aims to provide services or goods [1]. To survive the marketing competition, companies need to do good branding and positioning of products and choose the appropriate targets [2]. By utilizing technological and scientific advances through the study of neuroscience in neuromarketing, it is expected to create marketing strategies that are appropriate and able to meet the needs and desires of consumers, after several researchers on consumer behavior conducted by quantitative and qualitative methods, such as surveys.

However, the qualitative method has some shortcomings in branding [3]. The lack of data analysis in qualitative method is less trustable to know the consumer behavior, so many researchers switch into quantitative method using neuromarketing with EEG signal analysis. Nowadays, companies rely heavily on technological advances by doing digital marketing [4]. With digital marketing, changes in consumer behavior will be more easier to track [4]. The use of neuromarketing technology will provide consumer responses which previously unknown to be known [5]. The level of consumer interest in a product can be seen from the biological data recorded when looking at the logo or jingle of a product [6] . Neural technology used in marketing identifies a true response from a consumer [7]. In this case, neuromarketing plays an important role. Advances in neuroscience inform how a human brain's response works while marketing a product [4] [8].

The use of physiological signals to observe a color is one way to be used in addition to the subject's verbal feedback. Observing will be more understandable of consumers behavior and emerge new ideas [9]. Some companies do product marketing by creating logos with various colors. The use of the right colors by the company's characteristics makes consumers more interested in the products offered. Different colors between companies help consumers to remember the brand better. The color used in one company must be in the same color range because it will be the trademark of a company. In addition to EEG, can also do neuromarketing research techniques by using fMRI and eye-tracking. fMRI or Function Magnetic Resonance Imaging is used by identifying specific areas of the brain, such as areas that regulate levels of satisfaction, memory, and other active emotions at any given time. fMRI uses a magnetic resonance scanner. Eye-tracking is a technique used to identify how long the eye is focused on an observed object. The eye-tracking method also measures the movement of the eyes, and it is done to create a real-time scenario with a constituency. That way, eye-tracking displays internal brain activity. In addition to doing eye tracking directly, eye tracking can also be done online [10]. The disadvantage of using eye-tracking techniques is that when respondents observe an object for a long time, it is likely that the respondent will have difficulty understanding the object or the respondent will be more interested in the observed object [10].

This study was held for one year to analyze differences in brainwave responses to a famous brand logo in Indonesia by featuring two logos with different colors. One way to know consumers' responses to the logo of a brand is to run an interview. Using electroencephalography (EEG) to display brain signals that respond to the object provided. The signals will active or changed when the brain sees the color of the original logo and modified color of the logo. This data is obtained by how strong the brain's memory is on an object. This research is also referred as confirmation research, because this paper explains how a color can affect a person's attractiveness. Moreover, this research includes qualitative studies because the test is done by medically confirming areas of function in the human brain, especially in short-term memory areas.

1.1 Neuromarketing

Neuromarketing is a branch of neuroscience research. Neuroscience is a study that addresses marketing issues with methods and insights from brain research. Researchers consider neuromarketing is better and effective for several reasons, being able to predict consumer behavior without using questionnaires and interview methods accurately and reducing company costs for advertising products to be incurred [3]. Aspects that are considered in neuromarketing techniques are qualitative and quantitative. Qualitative covers problems such as media and content to customers, while quantitative includes the timing of consumers' advertisements [10]. The implementation of neuromarketing is widely used to analyze color, jingle, an image of a person's behavior. Neuromarketing is divided into auditory, visual, and tactile auditory influences on consumer behavior for a product's decision-making [11]. When deciding, consumer behavior is based on consumer emotions in a short time [12]. Neuroscience is used to collect various information about brain function and structure. The science branch of neuroscience is cognitive neuroscience, which is used to learn the mechanisms of brain function from various processes such as emotions, actions, and others. Neuroscience uses electroencephalography (EEG) and Functional Magnetic Resonance Imaging (fMRI) methods. While qualitative measurement of neuromarketing giving a non-detailed data because of human behavior where the respondent can be lied to or give a false data, quantitative neuromarketing provides more specific data through the human brain's signal. Neuroscience is still considered new because some studies focus on methods of human behavior. Non-invasive neuroscientific techniques are used to measure activity in the brain. The difference between electroencephalography (EEG) and Functional Magnetic Resonance Imaging (fMRI) is that the spatial resolution of fMRI is higher than EEG. But EEG has better temporal resolution than fMRI [13].

1.2 Electroencephalography (EEG)

Electroencephalography (EEG) is a tool used in neuromarketing research. EEG works by getting brain signals from analyzing electrical activity from brain waves. Signal measurement using EEG is an easy-to-use way to detect changes in brain activity in the absence of time delays. It can quickly weaken the subconscious response in humans [14]. EEG is one of the techniques that records electrical activity in the brain by placing electrodes on the scalp's surface [15]. The electrodes used have several channels as much as 10-20. It provides information about the polarity of ions, temperature, and electronic impulses generated by the brain [16]. Activity in the brain consists of two types, namely rhythm, and activity. Rhythm is a repetitive neural activity. Certain activities are a type of activity in the brain that reacts at a given time, recognizable by position, frequency, and amplitude. The various types of brain waves are Alpha, Beta, Delta, Theta, and Gamma. The difference between each wave is the working frequency band [17]. Alpha waves can be detected in the occipital region of the brain of an awake person, beta waves can be detected in the parietal and frontal lobes, theta waves can be detected in children and adults who do not perform strenuous or asleep activities, and delta waves can be detected in infants and adults while asleep [18]. Brain waves can be analyzed into data on emotions, behavior, and brain function [18].

Data obtained from these measurements will be analyzed according to emotions, feelings, and brain function [19]. That way, it can be concluded that brain activity recorded using EEG is very important and helps in the sensory research of consumers [20]. EEG is widely used for research due to its easy use, low cost, and higher resolution [3]. Now, EEG signals can display color stimulation signals and spectral power. But the EEG signal is stochastic where the results are not specific [9].

1.3 Butterworth Bandpass Filter

EGG signal usually has noise signal, therefore the amplitude of original signal is relatively small. This noise signal is often captured because of the respondent instability or because any other device nearby. Filtering is used to reduce the amplitude of noise signal without reducing the original signal. We used Butterworth Bandpass filter which provides a flat response frequency while filtering. We use theta-band, filtering, 4-8 Hz frequency of the signal.

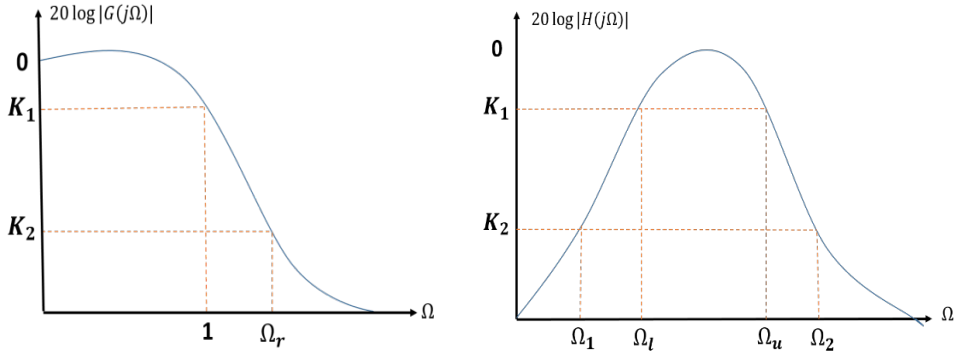


Figure 1. Test response (left); filtered test response (right)

1.4 Spatial Selection

Spatial selection is one of the channel selection methods by normalizing data from EEG signals and calculating the energy of Electroencephalography signals. Spatial selection will provide a matrix that defines the essential structure of the Electroencephalography [21]. Spatial filters will find the right time pattern for each signal session [21]. Spatial selection generally consists of two processes, namely, energy extraction and energy selection [22]. The energy extraction process has an L2-norm and leverage score [22]. This study uses the L2-norm method (1).

$$Pj = \frac{\sum_{i=1}^{m} A(i,j)^2}{\sum_{i=1}^{m}\sum_{i=1}^{n} A(i,j)^2} \quad (1)$$

Pj is an energy value, variable A is the matrix of the data, j is the column and i is the row. Variables n and m are the order of columns and rows [23]. Calculations of these equations were used in research trials. After the L2-norm method, the next step is to choose energy based on the best results obtained [24].

1.5 Related Work

Previous neuromarketing research used several methods such as Functional Magnetic Resonance Imaging (fMRI), Magnetoencephalography (MEG), Electroencephalography (EEG), and Eye Tracking. One fMRI [24] research on consumer decision making, researching multi-attribute decision-making in consumers based on the product evaluation context. The fMRI [25] study on data-driven methods applied to magnetic resonance fMRI in neuro-imaging [25] data. Success using the fMRI method is in selecting the number of components to be used [26]. One of MEG's studies [26] on MEG measured consumer behavior on perception, attention, and memory that can be used for advertising, product packaging, and new products. In the study [27] on MEG, it was mentioned that the number of sensors greatly influenced the cost, size, and weight of the meg system. Furthermore, in the study using eye-tracking [28]. It was examined on consumer behavior towards the view or eye movement based on pupillometry data, with stimulus in the form of site pages and advertising. Eye-tracking focuses on pupil size sensitive to distance and illumination of objects [29].

2. METHOD

This section explains the method and steps used in this research.

2.1 Data Acquisition

The data was taken from six respondents: three males and three females. This research's respondents are Telkom University students, with the age range of 19-24 years. The selection of stimulus objects is based on the top brand award survey results, and selected stimulus objects are Shopee, Bli-bli, Tokopedia, Zalora, and JD ID. The selection of these five brands is due to the dominance of the colors owned and the ease of visualizing brand colors displayed on the subject. This research's data were taken using Electroencephalography (EEG) Contec KT-88 16 channels as shown in Figure 2.

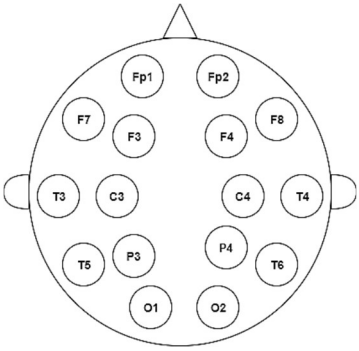


Figure 2. Contac KT-88-1016 Digital 16 channel EEG machine and mapping system

When collecting data, six respondents observe several logos in the form of the original and the modified color of the logo. Respondent is provided with a chair that has armrest, so that the subject is in a relaxing state. The subject is given a monitor to display the question screen. Researchers adjusted the distance of the chair with the monitor to adjust the visibility of each subject so that the screen display is visible. The resulting data is in the form of EEG signals as shown in Figure 3.

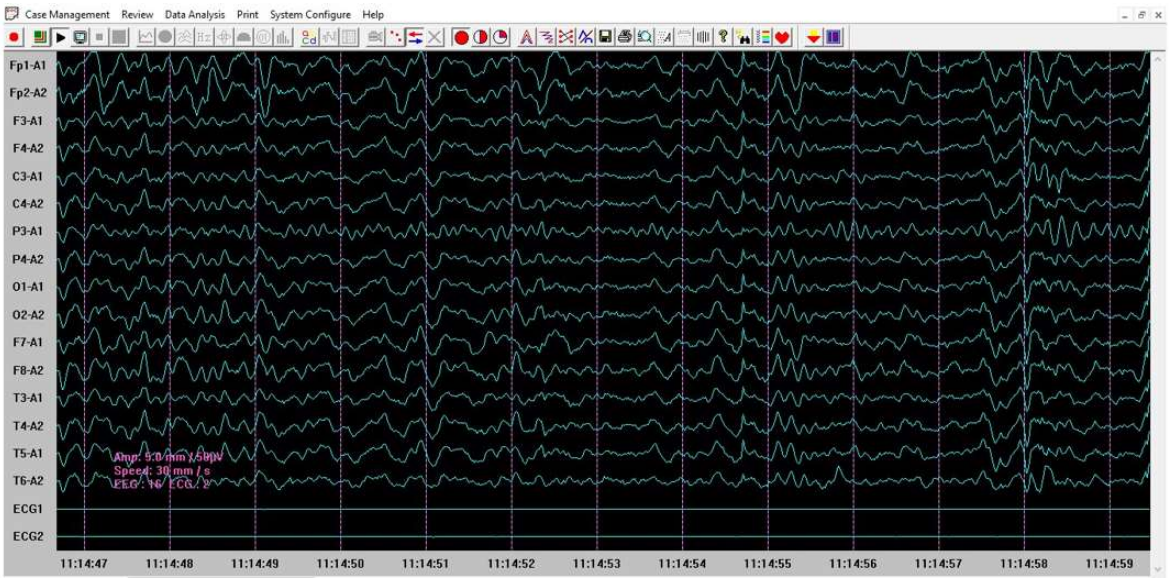


Figure 3. Resulting Data in The Form of EEG Signals

Timing diagrams on data retrieval can be seen in Figure 4.

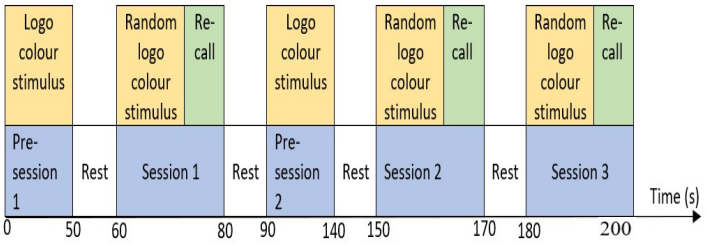


Figure 4. Timing Diagram

The explanation of each stage on the timing diagram is as follows:

1.) Pre-session

Pre-session is an opening activity as the researcher explains the data retrieval rules and steps to retrieve data to the respondents. In the pre-session stage, respondents were asked to observe a product or object provided. Pre-session consists of pre-session one and pre-session 2. In pre-session, one subject will show the logos of five brands with the original color of each brand's logo. In pre- session 2, subjects were given logos with colors that have been modified into one of the secondary colors and primary colors. The brand logo is displayed within 10 seconds for each logo. The pre-session is held for 40 seconds and then move to the rest session.

2.) Rest

In the rest stage, the aim is to neutralize the brain response so that when continuing to the next stage, the brain response is fresh, providing maximum results. Rest is held for 10 seconds then move to the session stage.

3.) Session

In this session, respondents will choose the product that they think the color of the product logo is right. The session consists of session 1, session 2, and session 3. In session 1, the subject will be given the logo of one brand with the original color at random for 10 seconds, and then blank screen appears for the subject to recall the previous object. The session is held for 20 seconds. Here are some brand logos with original colors and colors that have been modified as shown in Fig 5.

Figure 5. Original and Modified Brand Logo Color

2.2 Channel Selection

Channel selection is one of the technique to choose any optimal channel combination. Channel selection of EGG signal processing can be very helpful which can reduce the time required while running computation, and provides the respondent more comfort while running the stimulation. We reduced the all 16 channel to 4 channel which is reduced by 75%. There is two methods while selecting the channel. Manual selection uses classification algorithm to evaluate the channel subset, this method is easier to use, but it requires more time elapsed while running the process. Automatic selection is one of the methods which we create the criteria for the selected channel, this method uses no algorithm while picking the threshold of the brain's signal.

2.3 Pre-Processing

Data in the form of signals generated from the EEG then goes into the pre-processing stage with a data cut for 10 seconds according to the stimulus provided. The signal from the EEG consists of alpha, beta, theta, delta, and gamma signals as in Fig 6.

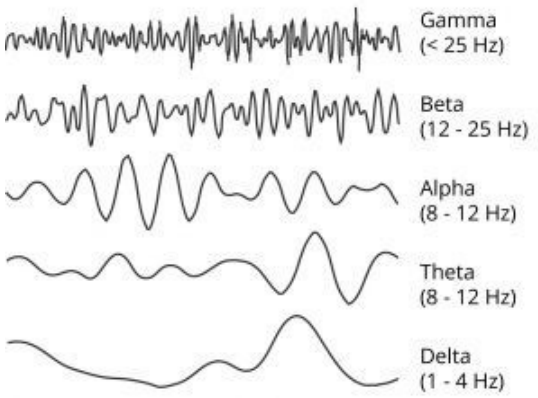


Figure 6. Brain Waves

2.4 Feature Extraction

In feature extraction, we will obtain resistance from the dataset from the EEG signal. The data generated from the EEG then goes into pre-processing of the data, cutting the data for 10 seconds according to the stimulus given. After pre-processing, data from the EEG is processed with a sampling frequency of 100 Hz using spatial selection, where the channel will be selected and sorted by the most significant energy. It will choose the results of the spatial selection four channels with the most significant energy. The four channels selected are called the active channel.

Furthermore, all the active channels that have been obtained will be sorted by selected channels that appear. The dominant channel selected is called the common active channel. The test determines whether the selected channel is in the memory by performing the characteristic extraction process with the application of spatial selection, as in Figure 7. Based on previous research [29] and [24], the channels used as reference channels for short-time memory are F3 and F4. O1 and O2 are used as reference channels for visual area.

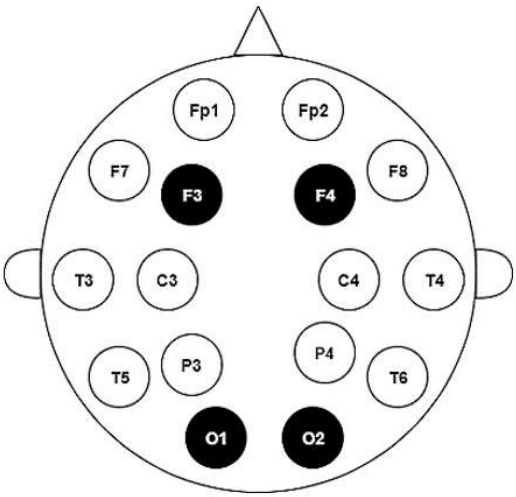


Figure 7. Active Channel (Black)

2.5 Correlation between Channel Composition on Short-Term Area and Brain's Memory

Respondent's memory is confirmed whether they give the answers right or wrong while questioned, according to the channel that active when answering. F3, F4, O1, and O2 were dominantly active on short-term memory signal with logo color stimulant.

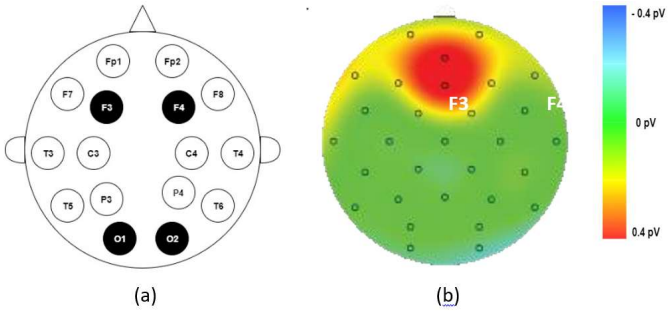


Figure 8. Channel Mapping of short term memory with visual stimulus based on reference channel (a); Memory's active area (b)

2.6 Classification

The selected channels are confirmed with memory and visual areas in the classification process as in the blue section, shown in Figure 9.

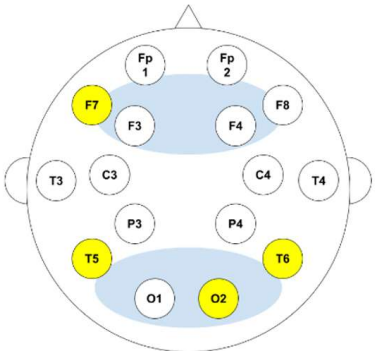


Figure 9. Channel Mapping in Memory and Visual Areas

3. RESULTS AND DISCUSSION

This study obtained experimental results and analysis of EEG signals with logo color stimulus to obtain short-term memory signal profiles. This research provides certain brand logos with different colors. There is a logo with the original color and a modified color. The study intends to find out if customers can still recognize the original brand logo when given some original and modified logos to observe. That way, we can know some of the effects of changing a product logo's color to a person's memory.

3.1. Marketing Analysis

The experiment results obtained from the subjects' answers when filling out a data retrieval questionnaire are seen in Table 1.

Table 1. Questionnaire Answer

Subject	Voice	Stimulus Color	Answer	Result	Probability brand
	1	Bli-bli	Bli-bli	True	27.78 %
1	2	Bli-bli	Bli-bli	True	27.78 %
	3	Shopee	Shopee	True	22.22%
	1	JD ID	JD ID	True	22.22%
2	2	JD ID	JD ID	True	22.22%
	3	Tokopedia	Tokopedia	True	16.67%
	1	Tokopedia	Tokopedia	True	16.67%
3	2	Shopee	JD ID	Wrong	22.22%
	3	Zalora	Zalora	True	11.11%
	1	Shopee	Shopee	True	22.22%
4	2	Bli-bli	Bli-bli	True	27.78 %
	3	JD ID	JD ID	True	22.22%
	1	Bli-bli	Bli-bli	True	27.78 %
5	2	Shopee	Bli-bli	Wrong	22.22%
	3	Zalora	Zalora	True	11.11%
	1	JD ID	JD ID	True	22.22%
6	2	Tokopedia	Bli-bli	Wrong	16.67%
	3	Bli-bli	Tokopedia	Wrong	27.78 %

The results of a post-data questionnaire on top brands showed that the subjects remembered the color of the original logo given. When the logo color was changed, some subjects had difficulty remembering the logo's color. From the data, obtained from 6 respondents and 18 sessions, for 14 sessions, the respondent answering the questions correctly, and 4 other sessions answered questions incorrectly.

In the study, probability values were obtained from each brand. Bli-Bli has the highest probability value of 27.78%, Shopee has 22.22%, JD ID has 22.22%, and Zalora has the lowest probability value of 11.11%. Brands with a high probability then the brand is increasingly stronger remembered by customers. At the same time, brands that have low probability value tend to be difficult to remember by customers. After taking data on top brands, the questionnaire results showed that the subjects remembered the color of the original logo. When changing the logo color, some subjects had difficulty remembering the logo's color.

The results of the post-data collection questionnaire on non-top brands showed that the subjects remembered the original logo color, and the subject remembered the color of the logo that had changed. Subjects remember logo colors that have been changed because both colors of the brand's non-top logo are changed to primary colors, based on primary color theory, which is easier to remember than secondary colors.

3.2. Common Channel Analysis

The measurements used Electroencephalography (EEG) with 16 channels, we select the channels that has the highest energy of any subject, selected the two largest most active. The common channel is the dominant channel that appears on every subject. Based on the common active channel results in Figure 9. For a common active channel, is channel F4 and channel O2. In the pre-session, the dominant active channel is the O2 channel that is for viewing, and in the active channel session section, the dominant is the F4 channel that is for remembering, and the O2 channel is for viewing [29], [30].

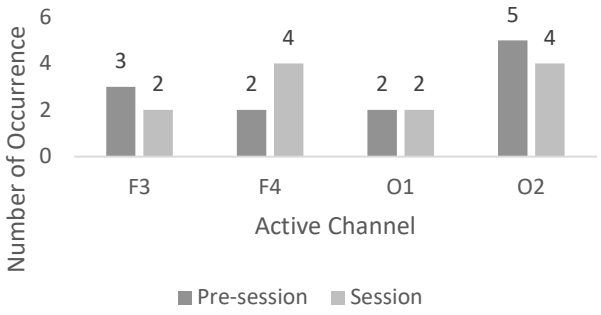
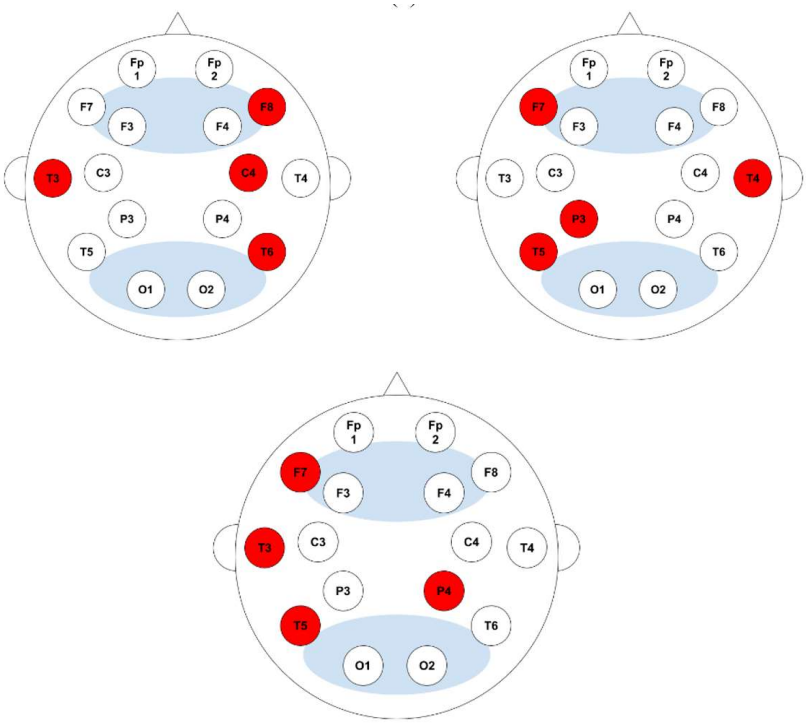


Figure 10. Common Active Channel

3.3. Active Area

When active area were processed or active channel was carried out, a profile will be obtained from the short-term memory signal from the EEG 16 channel with logo color stimulus. The yellow color indicates an active channel that works when the subject answers correctly. The blue color indicates the reference channel area, with the top being the area for memory and the bottom being for visuals. The red color indicates an active channel that works when the subject answers incorrectly. An active area that worked with the subject's correct answer indicated that the frontal or memory areas tended to be active. In contrast, the subject indicated that the active frontal and occipital areas tended to be less active with the false answer. The more a person remembers, the more nerves work on the front or front area of the memory. The active area can be seen in Figure 11.When the subject answers correctly, it means that he remembers, then the memory works with the active front memory area marked with a yellow channel. When the subject answers incorrectly, the active channel is not in the memory area. Mapping on a channel is done to see the active area when the subject answers correctly and when the subject answers incorrectly.

(a)



(b)

Figure 11. Channel Maping of a Subject; (a) answer correctly; (b) answer incorrectly

4. CONCLUSION

This research investigates whether a short-term memory active when given a stimulus. The result from the analysis is that the original logo color is more remembered than the logo color that has been modified. This is because the original logo color already has a characteristic attached to the consumer's memory. Furthermore, when giving a color stimulus to the logo, short-time memory will be in the frontal and occipital when in the active area. The frontal area is the area that confirms the presence of recall activity, while the occipital area is the area that confirms the presence of viewing activity. Based on the analysis, active channels are O2 channels for pre-sessions and F4 channels for sessions. When consumers are given the original logo color of the frontal and occipital areas will tend to be more active than when consumers are given a logo color that has been modified, so that consumers have difficulty recognizing, the frontal and occipital areas are less active. At the stage of channel selection obtained 4 effective channels with the greatest energy. With spatial selection, the channel became more effective by 75% when changing 16 channels to 4 channels, giving a optimal results. With this research, it is hoped that it can help some company or brand to determining the color for their brand logo, so that the brand logo is more recognizable and easier to remember by customers.

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